Advanced Fuel Forms Development Plan

-Series Two Fuel-

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For the

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Development of Innovative Fuel Forms

- Fuel forms which hold the potential for increased efficiency and reduced overall cost in processing, transmutation, and recycle -

The initial feed is Series One residual materials with lower Pu and greater MA content.

Approach: Perform Initial Assessment

- Gather information from literature and international fuel material experts
- Evaluate fuel system candidates for ease of fabrication and recycle
- Evaluate fuel system performance potential in fast neutron environment
- Down select to a few leading candidates
- Perform process tests and property measurements

Initial Direction:

Primary focus is on dispersion type fuel forms with actinide particles with metal or ceramic matrices

Metals:	Intermetallic compounds
	Noble metals
Ceramics:	Oxides (MgO, Al2O3, etc.)
	Borides (BN, BCN, etc.)
	Nitrides (refractory metal nitrides)

Micro structured fuel

Fuel Matrix Material Examples:

NiAl:

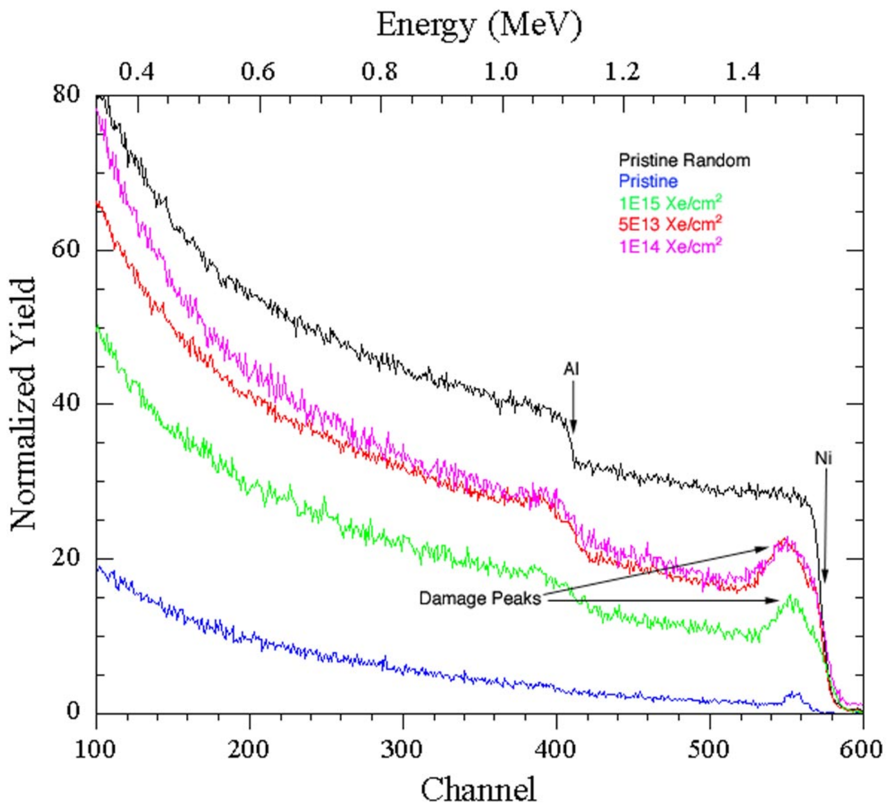
High TC, good melting point, excellent process experience, good recycle techniques

Noble Metals: Pd, Pt, Ru, etc.

High TC, abundant in SNF, stable in neutron environment, easily recycled

Radiation Damage Evolution in Single Crystal NiAl

A single crystal NiAl sample was irradiated under cryogenic conditions (~100K) with 450 keV Xe^{++} ions to fluences of $1 \cdot 0^{13}$, $5 \cdot 10^{13}$, and $1 \cdot 0^{14}$ Xe/cm^2. Samples were examined using Rutherford backscattering / ion channeling (RBS/C) following Xe ion irradiation.



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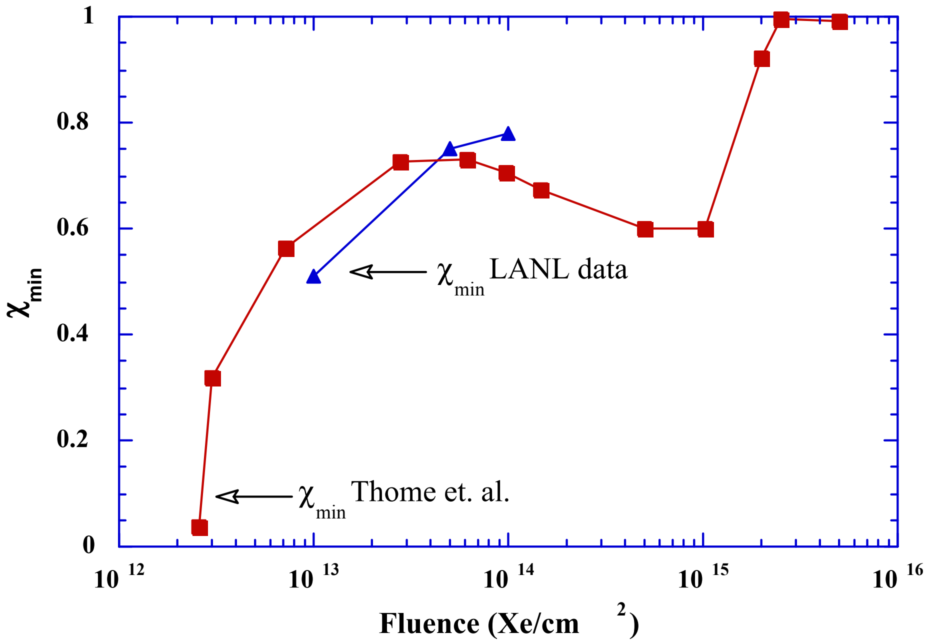

Comparison between the damage accumulation factor, χ_{min}, for RBS/C data obtained by Thomé et al. on 360 keV Xe^{++} ion irradiated NiAl at 90 K versus LANL obtained following irradiation with 450 keV Xe^{++} at 100K. The agreement between the measurements is excellent.

The rate of damage accumulation was observed to decrease dramatically with increasing fluence. The damage remained almost unchanged between fluences $5 \cdot 10^{13}$ and $1 \cdot 0^{14}$ Xe/cm^2; i.e., retained damage remained constant even though the displacement dose was doubled.

Actinide fuel Materials

Borides (^{11}B enriched)

Carbo-Borides

Boro-Nitrides

Oxides (most likely feed from recycle)

Nitrides

Possible Series Two Fuel Scenario

- Receive Pu & MA oxide feed powder
- Blend with precious metal powder
- Press into annular pellets
- Sinter at low temperature to densify
- Load into cladding tubes

  (Potentially use Pd-Tc alloy shims)

Innovative Fuel Development summary:

- There are several fuel forms of interest
- Fuel fabrication can be simplified
- Fuel performance can be enhanced
- Recycle processes can be simplified
- Modest increase in development costs but potential for large decrease in overall cost